

Australian/New Zealand Standard™

Low-voltage switchgear and controlgear

**Part 4.3: Contactors and motor-
starters—AC semiconductor controllers
and contactors for non-motor loads**



AS/NZS IEC 60947.4.3:2015

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-006, Industrial Switchgear and Controlgear. It was approved on behalf of the Council of Standards Australia on 27 May 2015 and on behalf of the Council of Standards New Zealand on 4 August 2015. This Standard was published on 23 September 2015.

The following are represented on Committee EL-006:

Association of Accredited Certification Bodies
Ausgrid
Australian Chamber of Commerce and Industry
Australian Industry Group
Bureau of Steel Manufacturers of Australia
Business New Zealand
Electrical Contractors Association of New Zealand
Engineers Australia
National Electrical and Communications Association
National Electrical Switchboard Manufacturers Association
Rail Industry Safety and Standards Board (RISSB)

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS IEC 60947.4.3:2015.

Australian/New Zealand Standard™

Low-voltage switchgear and controlgear

Part 4.3: Contactors and motor-starters—AC semiconductor controllers and contactors for non-motor loads

Originated as AS C63—1965.
Jointly revised and redesignated AS/NZS 3947.4.3:2000.
Jointly revised and redesignated AS/NZS IEC 60947.4.3:2015.

COPYRIGHT

© Standards Australia Limited/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140.

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-006, Industrial Switchgear and Controlgear, to supersede AS/NZS 3947.4.3:2000.

The objective of this Standard is to state—

- (a) the characteristics of semiconductor controllers and contactors and associated equipment;
- (b) the conditions with which semiconductor controllers and contactors should comply with reference to—
 - (i) their operation and behaviour;
 - (ii) their dielectric properties;
 - (iii) the degrees of protection provided by their enclosures, where applicable;
 - (iv) their construction;
- (c) the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests; and
- (d) the information to be given with the equipment or in the manufacturer's literature.

This Standard is identical with, and has been reproduced from, IEC 60947-4-3, Ed. 2.0 (2014), *Low-voltage switchgear and controlgear, Part 4.3: Contactors and motor-starters—AC semiconductor controllers and contactors for non-motor loads*. This edition cancels and replaces the first edition published in 1999, Amendment 1:2006 and Amendment 2:2011.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text ‘this part of IEC 60947 should read ‘this Australian/New Zealand Standard’.
- (b) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian/New Zealand Standard</i>	
IEC		AS/NZS	
61000	Electromagnetic compatibility (EMC)	61000	Electromagnetic compatibility (EMC)
61000-4-5	Part 4-5: Testing and measurement techniques—Surge immunity test	61000-4-5	Part 4.5: Testing and measurement techniques—Surge immunity test
CISPR		AS/NZS CISPR	
11	Industrial, scientific and medical equipment—Radio-frequency disturbance characteristics—Limits and methods of measurement Amendment 1 (2010)	11	Industrial, scientific and medical equipment—Radio-frequency disturbance characteristics—Limits and methods of measurement

Only normative references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annexes to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

CONTENTS

1	Scope	9
2	Normative references	10
3	Terms, definitions, symbols and abbreviations	10
3.1	Terms and definitions concerning a.c. semiconductor (non-motor-load) control devices	11
3.1.1	AC semiconductor controllers and contactors (solid-state contactors) (see Figure 1)	11
3.1.2	Hybrid controllers and contactors (see Figure 1)	14
3.2	Vacant	18
3.3	Symbols and abbreviations	18
4	Classification	18
5	Characteristics of a.c. semiconductor controllers and contactors	19
5.1	Summary of characteristics	19
5.2	Type of equipment	19
5.3	Rated and limiting values for main circuits	22
5.3.1	Rated voltages	22
5.3.2	Currents	22
5.3.3	Rated frequency	22
5.3.4	Rated duty	22
5.3.5	Normal load and overload characteristics	23
5.3.6	Rated conditional short-circuit current	24
5.4	Utilization category	24
5.4.1	Assignment of ratings based on the results of tests	25
5.5	Control circuits	26
5.6	Auxiliary circuits	26
5.7	Vacant	26
5.8	Coordination with short-circuit protective devices (SCPD)	26
6	Product information	26
6.1	Nature of information	26
6.2	Marking	28
6.3	Instructions for installation, operation and maintenance	28
7	Normal service, mounting and transport conditions	28
7.1	Normal service conditions	28
7.1.1	Ambient air temperature	28
7.1.2	Altitude	28
7.1.3	Atmospheric conditions	28
7.1.4	Shock and vibrations	29
7.2	Conditions during transport and storage	29
7.3	Mounting	29
7.4	Electrical system disturbances and influences	29
8	Constructional and performance requirements	29
8.1	Constructional requirements	29
8.1.1	General	29

8.1.2	Materials	29
8.1.3	Current-carrying parts and their connections	29
8.1.4	Clearances and creepage distances	29
8.1.5	Actuator	30
8.1.6	Indication of the contact position	30
8.1.7	Additional requirements for equipment suitable for isolation.....	30
8.1.8	Terminals	30
8.1.9	Additional requirements for equipment provided with a neutral pole	30
8.1.10	Provisions for protective earthing.....	30
8.1.11	Enclosures for equipment	30
8.1.12	Degrees of protection of enclosed equipment	30
8.1.13	Conduit pull-out, torque and bending with metallic conduits	30
8.2	Performance requirements.....	30
8.2.1	Operating conditions.....	30
8.2.2	Temperature rise	32
8.2.3	Dielectric properties.....	34
8.2.4	Normal load and overload performance requirements	35
8.2.5	Coordination with short-circuit protective devices	42
8.3	EMC requirements	42
8.3.1	General	42
8.3.2	Emission.....	43
8.3.3	Immunity.....	43
9	Tests	45
9.1	Kinds of tests	45
9.1.1	General	45
9.1.2	Type tests.....	45
9.1.3	Routine tests	45
9.1.4	Sampling tests.....	45
9.1.5	Special tests	46
9.2	Compliance with constructional requirements.....	46
9.3	Compliance with performance requirements	46
9.3.1	Test sequences	46
9.3.2	General test conditions	47
9.3.3	Performance under no load, normal load and overload conditions	47
9.3.4	Performance under short-circuit conditions	54
9.3.5	Disponible	58
9.4	General.....	58
9.4.1	EMC emission tests	58
9.4.2	EMC immunity tests.....	59
9.5	Routine and sampling tests	61
9.5.1	General	61
9.5.2	Operation and operating limits	61
9.5.3	Dielectric tests.....	61
Annex A (normative)	Marking and identification of terminals	62
A.1	General.....	62
A.2	Marking and identification of terminals of controller and contactors	62
A.2.1	Marking and identification of terminals of main circuits	62

A.2.2	Marking and identification of terminals of control circuits	62
A.2.3	Marking and identification of auxiliary circuits	62
Annex B (informative)	Typical service conditions for controllers and contactors	65
B.1	Control of resistive heating elements	65
B.2	Switching of electric discharge lamp controls	65
B.3	Switching of incandescent lamps	66
B.4	Switching of transformers.....	66
B.5	Switching of capacitor banks.....	66
Annex C	Vacant.....	67
Annex D	Vacant.....	68
Annex E	Vacant.....	69
Annex F (informative)	Operating capability.....	70
Annex G	Vacant.....	73
Annex H	Vacant.....	74
Annex I (normative)	Modified test circuit for short-circuit testing of semiconductor contactors and controllers.....	75
Annex J (informative)	Flowchart for constructing bypassed semiconductor controllers tests	77
Bibliography	78
Figure 1	– Graphical possibilities of controllers	13
Figure 2	– Methods of connecting	21
Figure F.1	– Thermal stability test profile	70
Figure F.2	– Overload capability test profile	71
Figure F.3	– Blocking and commutating capability test profile	72
Figure I.1	– Modified circuit for short-circuit testing of semiconductor devices.....	75
Figure I.2	– Time line for the short-circuit test of 9.3.4.1.6	76
Table 1	– Functional possibilities of controllers and contactors	14
Table 2	– Utilization categories	25
Table 3	– Relative levels of severity.....	25
Table 4	– Temperature rise limits for insulated coils in air and in oil.....	34
Table 5	– Intermittent duty test cycle data.....	34
Table 6	– Minimum overload current withstand time (T_x) in relation to overload current ratio (X)	36
Table 7	– Minimum requirements for thermal stability test conditions	37
Table 8	– Minimum requirements for overload capability test conditions	38
Table 9	– Minimum requirements and conditions for performance testing, including blocking and commutating capability.....	39
Table 10	– Making and breaking capacity test – Making and breaking conditions according to utilization categories for the mechanical switching device of hybrid semiconductor controller and contactor H4, H5	40
Table 11	– Conventional operational performance – Making and breaking conditions according to utilization categories for the mechanical switching device of hybrid controllers and contactors H4B, H5B	41
Table 12	– Specific performance criteria when EM disturbances are present	44

Table 13 – Thermal stability test specifications	51
Table 14 – Initial case temperature requirements	52
Table 15 – Terminal disturbance voltage limits for conducted radiofrequency emission.....	59
Table 16 – Radiated emissions test limits	59
Table A.1 – Main circuit terminal markings.....	62

INTRODUCTION

This part of IEC 60947 covers low-voltage a.c. semiconductor controllers and contactors (solid-state contactors) intended for the use with non-motor loads. As controllers, they have many capabilities beyond the simple switching on and off of non-motor loads. As contactors, they perform the same functions as mechanical contactors, but utilize one or more semiconductor switching devices in their main poles.

The devices may be single-pole or multi-pole (see 2.3.1 of IEC 60947-1:2007,). This standard refers to complete devices rated as a unit incorporating all necessary heat-sinking material and terminals. It includes devices with all necessary terminals, which are supplied with or without heat-sink in knocked-down form for combination by the users, when the manufacturer gives with the device detailed information about choosing the heat-sink and mounting the device on the heat-sink.

The generic term, "controller", is used in this standard wherever the unique features of the power semiconductor switching elements are the most significant points of interest. The generic term "contactor" is used in this standard wherever the feature of simple switching on and off is the most significant point of interest. Specific designations (for example, form 4, form HxB, etc.) are used wherever the unique features of various configurations comprise significant points of interest.

NOTES

AUSTRALIAN/NEW ZEALAND STANDARD

Low-voltage switchgear and controlgear

Part 4.3:

Contactors and motor-starters—AC semiconductor controllers and contactors for non-motor loads**1 Scope**

This part of IEC 60947 applies to a.c. semiconductor non-motor load controllers and contactors intended for performing electrical operations by changing the state of a.c. electric circuits between the ON-state and the OFF-state. Typical applications are classified by utilization categories given in Table 2.

As controllers, they may be used to reduce the amplitude of the r.m.s. a.c. voltage on the load terminals from that of the applied voltage – either continuously or for a specified period of time. The half-wave period of the a.c. wave form remains unchanged from that of the applied voltage.

They may include a series mechanical switching device and are intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c.

This standard characterizes controllers and contactors for use with or without bypass switching devices.

The semiconductor controllers and contactors dealt with in this standard are not normally intended to interrupt short-circuit currents. Therefore, suitable short-circuit protection (see 8.2.5) should form part of the installation but not necessarily of the controller itself.

In this context, this standard gives requirements for semiconductor controllers and contactors associated with separate short-circuit protective devices.

This standard does not apply to:

- operation of a.c. and d.c. motors;
- low-voltage a.c. semiconductor motor controllers and starters covered by IEC 60947-4-2;
- electronic a.c. power controllers covered by the IEC 60146 series;
- all-or-nothing solid-state relays.

Contactors and control-circuit devices used in semiconductor controllers and contactors should comply with the requirements of their relevant product standard. Where mechanical switching devices are used, they should meet the requirements of their own IEC product standard and the additional requirements of this standard.

The object of this standard is to state

- a) the characteristics of semiconductor controllers and contactors and associated equipment;
- b) the conditions with which semiconductor controllers and contactors should comply with reference to:
 - their operation and behaviour;
 - their dielectric properties;
 - the degrees of protection provided by their enclosures, where applicable;